

# SYNCHRONOUS SELF REFRESH EXIT CONTROL METHOD AND CIRCUIT IN SEMICONDUCTOR MEMORY DEVICE

## Field of Invention

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The present invention relates to a semiconductor memory device; and, more particularly, to a semiconductor memory device for controlling a synchronous self refresh exit operation for reducing a current consumed during self refresh operation.

## Description of Prior Art

Fig. 1 is a block diagram showing a self refresh control circuit in a conventional semiconductor memory device for controlling a self refresh exit operation.

As shown, the self refresh control circuit includes a self refresh entry unit 100, a self refresh exit unit 200 and a self refresh signal generator 5.

20 The self refresh entry unit 100 generates a self refresh entry signal SREF\_EN for starting a self refresh operation. The self refresh exit unit 200 generates a self refresh exit signal CKE\_SREF\_SYN for exiting from the self refresh operation.

25 The self refresh signal generator 5 receives the self refresh entry signal SREF\_EN and the self refresh exit signal CKE\_SREF\_EN and generates a self refresh signal SREF in

response to the two received signals SREF\_EN and CKE\_SREF\_EN.

The self refresh entry unit 100 includes a first buffer unit 1 and a self refresh entry command generator 3. The self refresh exit unit 200 includes a second buffer unit 2 and a  
5 synchronizing circuit unit 4.

The first buffer unit 1 includes a command buffer 11, a first clock enable buffer 12 and a first clock buffer 13.

The command buffer 11 receives external signals, i.e., a row address strobe signal RASB, a column address strobe signal  
10 CASB, a writing enable signal WEB and a chip selection signal CSB to generate internal signals, i.e., an internal row address strobe signal RASBI, an internal column address strobe signal CASBI, an internal writing enable signal WEBI and an internal chip selection signal CSBI.

15 The first clock enable buffer 12 receives an external clock enable signal CKE and generates an internal clock enable signal CKEI. The first clock buffer 13 receives an external clock signal CLK and generates an internal clock signal CLKI.

The above blocks 11, 12, and 13 also receive a  
20 feedbacked self refresh signal SREF. Depending on the feedbacked self refresh signal SREF, the blocks 11, 12 and 13 are enabled or disabled.

If the self refresh signal SREF is activated to a logic 'HIGH' level, the blocks 11, 12, and 13 are disabled; on the  
25 other hand, if the self refresh signal SREF is inactivated to a logic 'LOW' level, the blocks 11, 12 and 13 are enabled. That is, the first buffer unit 1 is disabled during the self

refresh operation.

The second buffer unit 2 includes a second clock enable buffer 21 and a second clock buffer 22. The second clock enable buffer 21 and the second clock buffer 22 receive the  
5 feedbacked self refresh signal SREF. Depending on the feedbacked self refresh signal SREF, the blocks 21 and 22 are enabled or disabled.

If the self refresh signal SREF is inactivated to a logic 'LOW' level, the second clock enable buffer 21 is  
10 enabled and outputs a self refresh exit control signal CKE\_SREF to the synchronizing circuit unit 4, wherein the self refresh exit control signal CKE\_SREF is not synchronized with the external clock signal CLK.

The second clock buffer 22 generates a clock  
15 synchronizing signal CLK\_SREF for synchronizing the self refresh exit control signal CKE\_SREF with the external clock signal CLK.

As described above, the conventional semiconductor memory device includes the second buffer unit 2 besides the  
20 first buffer unit 1. The second clock enable buffer 21 and the second clock buffer 22 are included in the second buffer unit 2. This is for receiving the clock enable signal CKE and the external clock signal CLK to control the self refresh exit operation. The first enable buffer 12 and the first clock  
25 buffer 13 are not used in order to reduce power consumption during the self refresh operation.

The self refresh entry command generator 3 generates the

self refresh entry signal SREF\_EN. If an auto refresh command signal AREF (now shown) is inputted when the clock enable signal CKE is in a logic 'LOW' level, the self refresh entry command generator 3 generates the self refresh entry signal SREF\_EN synchronized with the external clock signal CLK.

The synchronizing circuit unit 4 generates the self refresh exit signal by synchronizing the self refresh exit control signal CKE\_SREF with the clock synchronizing signal CLK\_SREF.

The self refresh signal generator 5 is for generating the self refresh signal SREF. The self refresh signal generator 5 controls the self refresh signal SREF to become a logic 'HIGH' level or a logic 'LOW' level depending on the self refresh entry signal SREF\_EN and the self refresh exit signal CKE\_SREF\_SYN, i.e., the self refresh signal generator 5 controls the SREF to become a logic 'HIGH' level if the SREF\_EN is activated, or, controls the SREF to become a logic 'LOW' level if the CKE\_SREF\_SYN is activated.

Fig. 2 is a timing diagram showing the self refresh operation of the conventional semiconductor memory device.

If the external clock signal CLK is inputted, and the clock enable signal CKE and an auto refresh signal AREF are also inputted synchronizing with the external clock signal CLK, the internal clock signal CLKI and the internal clock enable signal CKEI are generated. Herein, the auto refresh signal AREF is a mixed signal from the signals RASB, CASB, WEB, CSB described above.

Thereafter, the self refresh entry signal SREF\_EN is generated and inputted to the self refresh signal generator 5. Then, the self refresh signal SREF outputted from the self refresh signal generator 5 becomes in a logic 'HIGH' level.

5        Therefore, all the buffers except the second clock enable buffer 21 and second clock buffer 22 are disabled for reducing power consumption because the buffers included in the first buffer unit 1 are unnecessary in the self refresh operation.

10        On the other hand, to exit from the self refresh operation, the self refresh exit control signal CKE\_SREF is generated from the second clock enable buffer 21. Then, the self refresh exit signal CKE\_SREF\_SYN is generated from the synchronizing circuit unit 4 by synchronizing the CKE\_SREF  
15 with the clock synchronizing signal CLK\_SREF.

Thereafter, the self refresh SREF becomes in a logic 'LOW' level by the self refresh signal generator 5 indicating that the semiconductor memory device is out of the self refresh operation.

20        Subsequently, the buffers 11, 12 and 13 included in the first buffer unit 1 are enabled, and the buffers 21 and 22 included in the second buffer unit 2 are disabled.

As described above, during the self refresh operation, the conventional semiconductor memory device disables other  
25 buffers except for the second enable buffer 21 and the second clock buffer 22 in order to reduce power consumption.

However, during the self refresh operation, the buffers

21 and 22 still operate to thereby cause an additional power consumption.

Moreover, in a time period T as shown in Fig. 2, if the clock synchronizing signal CLK\_SREF outputted from the second clock buffer 22 keeps toggling during the self refresh operation so that the conventional semiconductor memory device further causes a power consumption.

#### Summary of Invention

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It is, therefore, an object of the present invention to provide a semiconductor memory device controlling a self refresh exit operation for reducing a power consumption during a self refresh operation.

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In accordance with an aspect of the present invention, there is provided a self refresh control device including a self refresh entry unit having at least one clock buffer for generating a self refresh entry signal in response to an external control signal, wherein the clock buffer generates a clock signal in response to an external clock signal and a clock buffer enable signal; a self refresh exit unit for generating a first self refresh exit signal in response to the external control signal and generating a second self refresh exit signal synchronized with the clock signal; a clock buffer controller for generating the clock buffer enable signal in response to the first self refresh exit signal; and a self refresh signal generator for generating a self refresh signal

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in response to the self refresh entry signal and the second self refresh exit signal.

#### Brief Description of the Drawings

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The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments taken in conjunction with the accompanying drawings, in which:

10        Fig. 1 is a block diagram showing a self refresh control units of a conventional semiconductor memory device;

      Fig. 2 is a timing diagram demonstrating a self refresh operation of the conventional semiconductor memory device;

15        Fig. 3 is a block diagram showing a semiconductor memory device in accordance with the present invention;

      Fig. 4 is a timing diagram showing a self refresh operation of the semiconductor memory device in accordance with the present invention;

20        Fig. 5 is a circuit diagram and a timing diagram showing an embodiment of a clock buffer controller and an operation of the clock buffer controller; and

      Fig. 6 is a circuit diagram and a timing diagram showing an embodiment of a next clock generator and an operation of the next clock generator.

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#### Detailed Description of Invention

Hereinafter, a semiconductor memory device in accordance with the present invention will be described in detail referring to the accompanying drawings.

Fig. 3 is a block diagram showing the semiconductor memory device in accordance with the present invention.

As shown, the semiconductor memory device includes a self refresh entry unit 100A, a self refresh exit unit 200A, a self refresh signal generator 50 and a clock buffer controller 60.

The self refresh entry unit 100A has a command buffer 101, a first clock enable buffer 102, a clock buffer 103 and a self refresh entry command generator 30.

The self refresh exit unit 200A has a second clock enable buffer 201, a next clock generator 70 and a synchronizing circuit unit 40.

The self refresh entry unit 100A generates a self refresh entry signal SREF\_EN synchronizing with an internal clock signal CLKI outputted from the clock buffer 103.

The clock buffer controller generates a buffer control signal BUF\_EN for enabling or disabling the clock buffer 103. If the semiconductor memory device is in a self refresh operation, the buffer control signal BUF\_EN disables the clock buffer 103; and, if a self refresh exit control signal CKE\_SREF is activated during the self refresh operation, the buffer control signal BUF\_EN enables the clock buffer 103.

The self refresh exit unit 200A generates a self refresh exit signal CKE\_SREF\_SYN by synchronizing the self refresh



exit control signal CKE\_SREF with an internal clock signal CLKI outputted from the clock buffer 103.

The self refresh signal generator 50 generates a self refresh signal SREF in response to the self refresh entry  
5 signal SREF\_EN and the self refresh exit signal CKE\_SREF\_SYN.

Therefore, the semiconductor memory device can control entry or exit of the self refresh operation synchronizing with the external clock signal CLK by using one clock buffer, i.e., the clock buffer 103.

10 The command buffer 101 receives several control signals like a row address strobe signal RASB and a column address strobe signal CASB. The first clock enable buffer 102 receives a clock enable signal CKE. The command buffer 101 and the first clock enable buffer 102 are disabled during the  
15 self refresh operation. The clock buffer 103 receives an external clock signal CLK.

The second clock enable buffer 201 receives the clock enable signal CKE operating during the self refresh operation. The self refresh entry command generator 30 outputs a self  
20 refresh entry signal SREF\_EN in response to outputted signals from the command buffer 101, the first clock enable buffer 102 and the clock buffer 103.

The clock buffer controller 60 disables the clock buffer 103 during the self refresh operation; and, enables the clock  
25 buffer 103 if the self refresh exit control signal CKE\_SREF is activated.

The next clock generator 70 generates a pulse signal

CLKI\_NEXT detecting the second clock of the internal clock signal CLKI. The synchronizing circuit unit 40 generates the self refresh exit signal CKE\_SREF\_SYN by synchronizing the self refresh exit control signal CKE\_SREF with the pulse  
5 signal CLKI\_NEXT.

The command buffer 101 receives a row address strobe signal RASB, a column address signal CASB, a writing enable signal WEB, a chip selection signal CSB and the self refresh signal SREF; and, outputs an internal row address strobe  
10 signal RASBI, an internal column address signal CASBI, an internal writing enable signal WEBI and an internal chip selection signal CSB after buffering those received signals.

The first clock enable signal 102 receives the clock enable signal CKE and outputs an internal clock enable signal  
15 CKEI. At this time, the self refresh signal SREF generated from the self refresh signal generator 50 is feedbacked and inputted to the command buffer 101 and the first clock enable buffer 103. The two blocks 101 and 102 are disabled or enabled by the feedbacked self refresh signal SREF, i.e., the  
20 two blocks 101 and 102 are disabled if the SREF is in a logic 'HIGH' level, and the two blocks 101 and 102 are enabled if the SREF is in a logic 'LOW' level.

The clock buffer 103 is controlled by the buffer control signal BUF\_EN. The clock buffer 103 is disabled if the BUF\_EN  
25 is in a logic 'HIGH' level and enabled if the BUF\_EN is in a logic 'LOW' level.

The clock enable buffer 201 is for generating the self

refresh exit control signal CKE\_SREF. The clock enable buffer 201 is enabled if the refresh signal SREF is in a logic 'HIGH' level and disabled if the refresh signal SREF is in a logic 'LOW' level.

5       The self refresh entry command generator 30 is for generating the self refresh entry signal SREF\_EN. The self refresh entry command generator 30 generates the self refresh entry signal SREF\_EN if an auto refresh auto refresh command signal AREF (now shown) is inputted and the clock enable  
10      signal CKE is in a logic 'LOW' level.

      The synchronizing circuit unit 40 generates the self refresh exit signal CKE\_SREF\_SYN by synchronizing the self refresh exit control signals CKE\_SREF with the pulse signal CLKI\_NEXT.

15       The self refresh signal generator 50 generates the self refresh signal SREF. The self refresh signal SREF becomes in a logic 'HIGH' level or in a logic 'LOW' level. If the self refresh entry signal SREF\_EN is activated, the SREF becomes in a logic 'HIGH' level; and, if the self refresh exit signal  
20      CKE\_SREF\_EN is activated, the SREF becomes in a logic 'LOW' level.

      Fig. 4 is a timing diagram demonstrating the self refresh operation of the semiconductor memory device in accordance with the present invention.

25       As shown, the self refresh entry signal SREF\_EN becomes in a logic 'HIGH' level synchronizing with the internal clock signal CLKI after the internal clock enable signal CKEI

becomes inactivated. After that, the self refresh signal SREF is activated to a logic 'HIGH' level, and the semiconductor memory device is in the self refresh operation.

Thereafter, the buffer control signal BUF\_EN becomes in  
5 a logic 'HIGH' level in response to the self refresh signal SREF, and, the clock buffer 103 is disabled by the buffer control signal BUF\_EN.

Meanwhile, during the self refresh operation, the second  
clock enable buffer 201 is enabled and outputs the self  
10 refresh exit control signal CKE\_SREF from the inputted clock enable signal CKE.

If the self refresh exit control signal CKE\_SREF becomes  
in a logic 'HIGH' level during the self refresh operation, the  
buffer control signal BUF\_EN becomes in a logic 'LOW' level  
15 and the clock buffer 103 is enabled. Therefore, the internal clock signal CLKI is outputted from the clock buffer 103.

Thereafter, the pulse signal CLKI\_NEXT becomes in a  
logic 'HIGH' level synchronizing with the second rising edge  
of the internal clock signal CLKI. Then, the self refresh  
20 exit signal CKE\_SREF\_EN is activated to a logic 'HIGH' level synchronizing with the pulse signal CLKI\_NEXT. Therefore, the semiconductor memory device is out of the self refresh operation.

Fig. 5 shows a circuit diagram and a timing diagram.  
25 The circuit diagram shows an embodiment of the clock buffer controller 60 and the timing diagram shows an operation of the clock buffer controller 60.

As shown, the clock buffer controller 60 includes a first input unit 61, a second input unit, an RS-LATCH 62 and an output unit 68.

The first input unit 61 is embodied by a pulse generator and generates a reset pulse signal RESET by detecting a rising edge of the self refresh exit control signal CKE\_SREF outputted from the second clock enable buffer 201.

The second input unit generates a set signal SET if the self refresh signal SREF is activated; or, if the pulse signal CLKI\_NEXT is activated and the self refresh exit signal CKE\_SREF\_SYN is inactivated.

The second input unit is provided with a delay 63, an inverter 65, a pulse generator 64, an AND gate 66 and an OR gate 67.

The delay 63 delays the pulse signal CLKI\_NEXT and the inverter 65 inverts the self refresh exit signal CKE\_SREF\_SYN. The AND gate 66 performs a logic AND operation on the two outputted signals from the delay 63 and the inverter 65. The pulse generator 64 generates a pulse signal synchronizing with a rising edge of the refresh signal SREF. The OR gate 67 performs a logic OR operation on the two outputted signals from the AND gate 66 and the pulse generator 64.

The RS-LATCH receives the reset signal RESET and the set signal SET. The output unit 68 is embodied by an AND gate and performs a logic AND operation on the outputted signal from the RS-LATCH 67 and the refresh signal SREF, then, outputs the buffer control signal BUF\_EN.

Referring to the timing diagram, if the self refresh signal SREF becomes in a logic 'HIGH' level, the set signal SET and buffer control signal BUF\_EN become in a logic 'HIGH' level. After that, if the self refresh exit control signal  
5 CKE\_SREF becomes in a logic 'HIGH' level, the reset signal RESET is generated for resetting the RS-LATCH 62, then, the buffer control signal BUF\_EN becomes in a logic 'LOW' level.

Fig. 6 shows a circuit diagram and a timing diagram. The circuit diagram shows an embodiment of the next clock  
10 generator 70 and the timing diagram shows operation of the next clock generator 70.

As shown, the next clock generator 70 includes an input unit, a toggle flip-flop 73 and a pulse generator 74; herein, the input unit is provided with an inverter 71 and an AND gate  
15 72.

The input unit receives the internal clock signal CLKI and the self refresh exit signal CKE\_SREF\_SYN; and, transfers the internal clock signal CLKI to the toggle flip-flop 73 if the self refresh exit signal CKE\_SREF\_SYN is inactivated,  
20 where the transferred internal clock signal CLKI is renamed as CLKI2.

The input unit is provided with an inverter 71 and an AND gate 72. The inverter 71 inverts the self refresh exit signal CKE\_SREF\_SYN. The AND gate 72 performs logic AND  
25 operation on the internal clock signal CLKI and the outputted signal from the inverter 71.

The toggle flip-flop 73 receives the outputted signal

CLKI2 from the AND gate 72 and generates a toggle signal CLKI\_TOG. The toggle signal CLKI\_TOG toggles at rising edges of the CLKI2.

The output unit 74 is embodied by a pulse generator.  
5 The output unit 74 generates the pulse signal CLKI\_NEXT at a falling edge of the CLKI\_TOG.

Referring to the timing diagram shown in Fig. 6, if the internal clock signal CLKI is inputted, the toggle signal CLKI\_TOG is generated from the toggle flip-flop 73. Then, the  
10 pulse signal CLKI\_NEXT is generated synchronizing with a falling edge of the CLKI\_TOG.

While the present invention has been described with respect to the particular embodiments, it will be apparent to those skilled in the art that various changes and  
15 modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.